REVIEW

about the PhD thesis for acquisition of the educational and scientific degree "doctor" in the professional field 5.3 "Communication and computer technics", doctoral program "Computer systems, complexes and networks",

Author of the PhD thesis: MSc eng. Marieta Metodieva Haka

Topic of the PhD thesis: Approaches for increasing the security of IoT networks

Reviewer: Prof. eng. Grisha Valentinov Spasov, PhD, TU – Sofia, Plovdiv Branch, Department of Computer Systems and Technologies, e-mail: gvs@tu-plovdiv.bg

1. Actuality of the problems in the PhD thesis

The proposed PhD thesis deals with an indisputably actual and important topic related to research and analysis of the security in the communication layer of Internet of Things (IoT) networks, with the aim of increasing security in IoT applications based on the ZigBee wireless sensor network. The object of research are the approaches, methods and algorithms applicable to increasing the security of IoT networks, the methods for their simulation and experimental research, as well as the development of an experimental platform for their practical investigations. The developed specific tasks solved in the dissertation work have a direct practical application in increasing the security of IoT networks based on ZigBee.

2. Degree of knowledge of the state of the problem

The literature review in Chapter 1 and the analysis made in it show a very good knowledge of the topic related to analyzing approaches for increasing the security of IoT networks, considering vulnerabilities in their security, as well as the applied methods and algorithms used to integrate network security. The references (166 in total) are related to the subject of the dissertation work, and are mainly written in English.

The literature review ends with an analysis and conclusions, on the basis of which the goal of the PhD thesis and the tasks for its implementation are defined.

3. Correspondence of the chosen research methodology with the set goal and tasks of the PhD thesis.

The research methodology chosen by the PhD student makes it possible to achieve the main goal of the dissertation "to develop approaches to increase security in IoT networks implemented with ZigBee".

Methodologically, the dissertation follows the logical sequence:

- Introduction to approaches for increasing the security of IoT networks and related methods and algorithms for their implementation. The need to improve existing security approaches in ZigBee networks for IoT is formulated;
- Proposing approaches to increase security in IoT networks implemented with ZigBee wireless technology, by applying cryptographic algorithms. Researching and proposing

an approach for analytical determination of the security level parameter in ZigBee networks and a scale for determining the security level grades;
- Research and proposal of a system of indicators for evaluating simulation products used for security research in ZigBee networks. Proposal of a methodology and development of a simulator for researching security processes in ZigBee networks;
- Simulation study of the proposed methods and algorithms for increasing security in ZigBee IoT networks;
- Development of a prototype ZigBee network for IoT, in which to explore experimentally different approaches for increasing security;
- Experimental study of the proposed approaches and methods for increasing security in ZigBee IoT networks.

I believe that the research methodology used is in accordance with the goal and objectives of the dissertation.

4. Characteristics of the PhD thesis

The presented dissertation is 229 pages long and includes appendices. The research is presented in an introduction and 3 chapters, a list of contributions, a list of publications, references and 4 appendices.

In the introductory part the problems of the dissertation are introduced.

The first chapter provides an overview of approaches to enhance the security of IoT networks and the related methods and algorithms for their implementation. The need to improve existing security approaches in ZigBee networks for IoT is formulated. The chapter ends with the relevant conclusions, justifying the goal of the dissertation and the tasks for its achievement.

Chapter two presents the motivations for creating an approach to enhance security in IoT networks implemented with ZigBee wireless technology, through the application of cryptographic algorithms. The necessary functionalities for a simulator providing the possibility of studying security in ZigBee networks for IoT are defined. The implementation of a specialized simulator for security research in ZigBee networks for IoT - ZBeeSiM is proposed.

In chapter three, experimental studies of security-related processes in ZigBee networks are conducted in both simulated and real environments. The proposed approaches for increasing the level of security are investigated and validated using the ZBeeSiM simulator proposed in this dissertation. A methodology for experimental research and implementation of the test platform is proposed. A methodology for validating the simulation results by comparing them with measurements in a real working environment is presented.

The conclusion summarizes the results of the research in the dissertation and gives guidelines for future work.

5. Contributions to the PhD thesis

I accept in principle the contributions formulated by the PhD student, which can be classified as scientific, scientific-applied and applied. They are summarized after the last chapter of the dissertation. I believe that the formulated contributions show that the defined tasks have been fulfilled. This approach for presenting the contributions is appropriate because it connects the formulated goal and tasks of the dissertation with the achieved results.

The following scientific contribution can be mentioned:

- The proposed analytical expression for calculating the security level in ZigBee networks and a scale for determining the security level grades.

The most important scientific and applied contributions are the following:

- The proposed adaptive approach to improve the security level in ZigBee networks.
- The defined system of indicators for evaluating simulation products for security research in ZigBee networks.

Applied contributions:
- The developed simulator for studying security processes in ZigBee networks.
- The developed prototype ZigBee network for IoT, in which security was experimentally studied, and the proposed scale for determining the security level grades.

The scientific contribution in the dissertation work can be attributed to the formulation and justification of a new scientific problem. Scientific and applied contributions belong to the following two groups: proving with new means significant new aspects of existing scientific problems and theories; creating new models, technologies and algorithms. Nature of implementation contributions: methodologies and algorithms, a prototype simulator and a ZigBee network.

I believe that the achieved results, the scientific and applied contributions are mainly a personal work of the candidate. They prove that the PhD student has the capacity to perform research and engineering activities independently.

6. Evaluation of the publications on the PhD thesis

Five publications are presented, four of them co-authored with the doctoral supervisor and one with the PhD student as the only author. Four of the publications (P1, P3, P4, P5) were presented at international conferences indexed in SCOPUS, and one (P2) was published in a journal. For publication P1, two citations were found in SCOPUS.

All publications are directly related to the issues addressed in the dissertation.

The reviewer believes that the number and quality of the submitted publications on the topic of the dissertation, as well as their citations, significantly exceed the requirements for obtaining the educational and scientific degree “doctor” in Scientific Field 5.3.

7. Significance of the results of the PhD thesis for science and practice.

The PhD student has completed a large amount of work, distinguished by thoroughness and competence. The work is significant not only because of its scientific and applied achievements, but also because of the possibility of direct practical application of the significant improvements achieved in increasing security in IoT networks implemented with ZigBee wireless technology. The work provides a solid foundation for future research and experimental validation of simulated processes, as well as for the implementation of new approaches related to the security of IoT networks.

8. Assessment of the conformity of the abstract with the requirements for its preparation.

The abstract, in a volume of 36 pages, meets the requirements and presents the content, main achievements, research results and contributions of the dissertation.

9. Opinions, recommendations and notes.

The educational objectives of the dissertation have been fully met.

Notes:
• Not all scientific and applied contributions resulting from the PhD student's research have been summarized.

Recommendations:
• The achieved results should be compared with other similar results obtained in alternative research in the field of the dissertation.

I have no remarks regarding the quantity and quality of the work done in the dissertation.

10. Conclusion

My assessment of the dissertation, the abstract and the publications reflecting the research in the dissertation is positive. The dissertation contains scientific, scientific-applied and applied contributions to a sufficient degree and meets the requirements of the Law for development of the academic staff in the Republic of Bulgaria and the Regulations for its implementation, as well as the Regulations for the conditions for acquiring scientific degrees in TU- Varna.

As a result of the above-mentioned achievements in the dissertation, I propose to the Scientific Jury to award to MSc eng. Marieta Metodieva Haka educational and scientific degree "Doctor", in the professional field 5.3. “Communication and computer technics”, doctoral program "Computer systems, complexes and networks".

Date: January, 08, 2026. Reviewer:

(Prof. eng. Grisha Spasov, PhD)